



## 2011 ASSESSMENT OF 4VWX HERRING

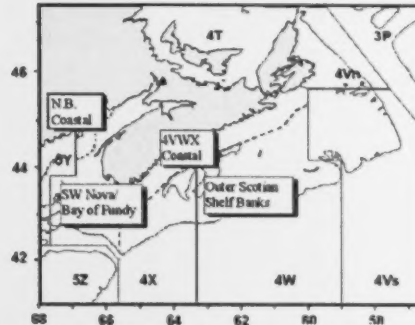


Figure 1. 4VWX herring management area and stock component locations.

### Context:

In support of scientific advice for the 2010/11 fishery, the 2011 assessment of the 4VWX herring stock complex was reviewed through a Science Advisory Process. The meeting was held April 7-8, 2011, in Dartmouth, N.S. to review and evaluate biological and fishery information on 4VWX herring status as a basis for establishing quota for the 2010/2011 fisheries, as required in the Integrated Fisheries Management Plan. The terms of reference included an evaluation of the Southwest Nova Scotia (SWNS)/Bay of Fundy spawning component, compilation and review of information regarding the offshore Scotian Shelf and the coastal Nova Scotia spawning components, an update on southwest New Brunswick migrant juvenile fishery component, and recommendations to management on stock status. Participants included scientists, fishery managers, representatives of the industry, provincial governments, and other stakeholders. The last assessment of this resource was in 2010.

The 2003-2010 Scotia-Fundy Herring Integrated Fisheries Management Plan (IFMP) set out principles, conditions, and management measures for the 4VWX herring fisheries (DFO 2003). The main principle stated in the plan is "the conservation of the herring resource and the preservation of all of its spawning components". Three conservation objectives appear in the plan:

- 1) To maintain the reproductive capacity of herring in each management unit through:
  - persistence of all spawning components in the management unit;
  - maintenance of biomass of each spawning component above a minimum threshold;
  - maintenance of a broad age composition for each spawning component; and
  - maintenance of a long spawning period for each spawning component.
- 2) To prevent growth overfishing:
  - continue to strive for fishing mortality at or below  $F_{0.1}$ .
- 3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance"):
  - maintain spatial and temporal diversity of spawning; and
  - maintain herring biomass at moderate to high levels.

Progress against these objectives was evaluated at this meeting. Since 1995, the herring stock assessment and related research has been increasingly dependant on a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological characteristics of the catch, as well as acoustic surveys using industry vessels and tagging. A major review of the assessment framework, including aspects of stock structure, sampling and tagging results, acoustic surveys and design, was conducted in the fall and winter of 2006/07 (DFO 2007). A framework meeting to evaluate and review alternative assessment models/approaches took place in January 2011. No model was chosen but recommendations for the assessment were provided in the report (DFO 2011).

## **SUMMARY**

### **SW Nova Scotia / Bay of Fundy**

- Landings for the 2009/2010 quota year were 45,534t against a Total Allowable Catch (TAC) of 55,000t for the Southwest Nova Scotia (SWNS)/Bay of Fundy component. Landings have tracked the TAC in recent years, with most of the quota being taken each year since 2002. In 2010, as a result of an industry decision late in the season 9,466t of quota was left in the water. This was in order to avoid catching and adding more fish of a size of less than 23cm to the 2010 landings.
- In 2009, the fishery catch at age composition was comprised of 45% fish by number at 2 years of age and 7% older than age 5. In 2010 there were 60% fish by number at age 2 and only 3% older than age 5 in the catch. Acoustic survey age composition had a broad age distribution of spawning fish with ages 3-11 and 15% older than age 5.
- In 2010, biomass estimates decreased in the main areas for Scots Bay and German Bank to a total of 312kt, which is a decrease of approximately 175kt from 2009 (36% decrease). The amount of spawning fish documented on Trinity Ledge in 2010 was again extremely low.
- There has been a trend of declining mean-weight at age but it was significantly more than would have occurred if the trend continued in 2010. About 10-15% of the observed decline in stock spawning biomass (SSB) from 2009 to 2010 can be attributed to this reduced mean weight at age. This unexpected reduction was consistent with the unusual environmental conditions in 2010. Declining trends in mean-weight at age since the 1970s has reduced productivity of the stock.
- Relative exploitation rate has been constant in response to changes in survey biomass.
- SSB has declined from the average of 551kt to 377kt (32% reduction) for the time periods 2001-2004 to 2005-2010. This assessment indicates stability at the lower level from 2005-2010 and shows little or no signs of improvement. This lack of rebuilding despite reduced catch levels in recent years is cause for concern.
- Harvest strategy that exercises caution, including additional restrictions in small fish removals, is appropriate.

### **Offshore Scotian Shelf Banks**

- Since 1996, a fishery has taken place on feeding aggregations on the offshore banks of the Scotian Shelf, primarily in May and June, with catches ranging from 1,000 to 20,000t. In 2010, almost the entire allocation was caught with total landings above average at 11,862t.
- An industry survey of the offshore Scotian Shelf area was conducted on 'The Patch' in June 2010, with 3.5kt of biomass estimated. The industry is again encouraged to explore and undertake further structured surveys of the offshore area in 2011.
- There is minimal new information to add and no reason to change the previous recommendation that the initial catch allocation for 2011 should not exceed 12,000t as described in the DFO management plan.

### **Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia**

- The landings in the roe gillnet fisheries along the coast of Nova Scotia decreased from 9,783t in 2009 to 5,575t in 2010.

- In 2010 the survey biomass for the Little Hope/Port Mouton area declined to 26.7kt, just above the recent 5 year average of 20.9kt. The survey biomass in the Halifax/Eastern shore area declined to 27.7kt, well below the recent 5 year average of 41.9kt.
- Collaborative research with industry has improved knowledge of three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge of other areas. It is again recommended that no coastal spawning groups experience a large effort increase in new areas until enough information is available to evaluate the state of that spawning group.
- It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern, but there has been no research or surveys in recent years. It is; therefore, appropriate to reiterate that no fishing should take place on this spawning component.
- Harvest levels from these areas use a five year average of recent catches and/or surveyed acoustic biomass with the Calibration Integration Factor (CIF) to set initial targets. It is recommended that the "survey, assess, then fish" protocol should continue to be applied.

### **SW New Brunswick Migrant Juvenile**

- The southwest New Brunswick juvenile herring (ages 1-3) are considered to be a mixture of juveniles, dominated by those originating from Northwest Atlantic Fisheries Organization (NAFO) Subarea 5 spawning components, and have, therefore, been excluded from the SW Nova Scotia/Bay of Fundy quota.
- Landings in the 2010 New Brunswick weir and shut-off fishery were 10,958t, up from the low of 4,031t in the previous year. It is notable that as recently as 2007 landings were 30,944t, the highest in nearly 20 years and higher than the long term average of 23,560t.
- The age distribution of fish caught in the 2010 New Brunswick weir and shutoff fishery were mostly juveniles, which are well suited to the sardine market, with 95% at age 2.
- The number of weirs with catches increased in the 2010 season, but effort (number of active weirs) remained similar.
- The success of this passive fishery is historically unpredictable, and catches are inherently susceptible to many natural variables in addition to abundance.

## **BACKGROUND**

### **Species Biology**

Atlantic herring (*Clupea harengus*) is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they have a strong affinity. Herring mature in 4VWX and first spawn at three or four years of age, then begin an annual pattern of spawning, over-wintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Fishing takes place on dense summer feeding, over-wintering, and spawning aggregations. The majority of herring in the 4VWX area are fall spawners.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same component. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localized, sometimes very near shore or in small embayments. The situation is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same component and

with members of other components. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components:

1. SW Nova Scotia / Bay of Fundy spawning component
2. Offshore Scotian Shelf banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component
4. SW New Brunswick migrant juveniles

Each component except southwest (SW) New Brunswick migrant juveniles has several spawning areas, and there is mixing of fish among spawning components outside of the spawning period.

## **Fishery**

Fisheries in the 4VWX area in recent years have been dominated by purse seine (95%), followed by weir, gillnet, shutoff and trap.

Landings for the 2009/2010 quota year were 45,534t against a Total Allowable Catch (TAC) of 55,000t for the SW Nova Scotia/Bay of Fundy component (Table 1). Landings have tracked the TAC in recent years, with most of the quota being taken each year since 2002. In 2010, as a result of an industry decision late in the season 9,466t of quota was left in the water. This was in order to avoid catching and adding more fish of a size of less than 23cm to the 2010 landings (Figure 2).

Table 1. Reported landings (thousands of tonnes) and TAC for the 4WX herring management unit by component from 2005 to 2010 with averages for recent and prior decades.

| Year                                | Average<br>1970-79 | Average<br>1980-89 | Average<br>1990-99 | Average<br>2000-09 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|-------------------------------------|--------------------|--------------------|--------------------|--------------------|------|------|------|------|------|------|
| 4WX SW Nova Scotia TAC <sup>1</sup> | 106                | 106                | 112                | 69                 | 50   | 50   | 50   | 55   | 55   | 55   |
| 4WX SW Nova Scotia <sup>1</sup>     | 131                | 131                | 96                 | 66                 | 49   | 50   | 50   | 55   | 54   | 46   |
| 4VWX Coastal NS <sup>2</sup>        | <1                 | <1                 | 4                  | 7                  | 7    | 7    | 5    | 4    | 10   | 6    |
| Scotian Shelf Banks <sup>2</sup>    | 38                 | <0.1               | 13                 | 6                  | 5    | 10   | 5    | 1    | 9    | 12   |
| SW New Brunswick <sup>2</sup>       | 26                 | 24                 | 24                 | 15                 | 13   | 13   | 31   | 6    | 4    | 11   |
| Total Landings                      | 172                | 155                | 137                | 93                 | 74   | 79   | 92   | 66   | 77   | 74   |

1 - Quota year from Oct. 15 of the preceeding year to Oct 14 of the current year

2 - Calendar year from Jan. 1 to Dec. 31

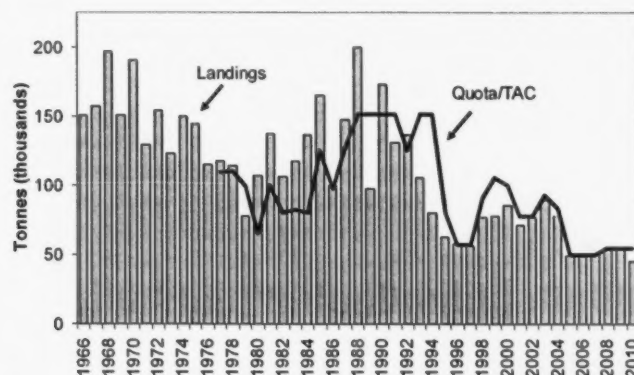


Figure 2. Landings (thousands of tonnes) and TAC for the SW Nova Scotia/Bay of Fundy spawning component.

There were additional landings of 28,395t taken in the non-stock components for an area total of 73,929t. Landings increased from the New Brunswick weirs and shutoffs as well as the Scotian Shelf Banks yet decreased from the Coastal Nova Scotia component. Purse seine catches by fishing grounds were unlike recent years with the largest proportions reported from the German Bank (40%), Grand Manan (35%), and Scots Bay (9%) areas. There was a decrease in catches by tonnage and relative proportions in most of the other fishing grounds in the Bay of Fundy area.

Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and taking appropriate account of the interaction among components (such as fishing restrictions on some areas of mixing). Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in lost potential yield. Since 2005, industry had made a concerted effort to avoid small fish (less than 23cm or 2 years old). The total removals of fish by number were reduced by close to 50% from 2005 to 2008 relative to 2004, however they increased in 2009 with the catch of a large proportion of 2 year olds (45%) by number. This increase in catch of 2 year olds in 2009 was attributed at the time to a potentially large 2007 year-class but these did not appear at age 3 in significant numbers in the 2010 catch.

The numbers of removals of 2 year olds increased substantially in 2010 due to a strong market for lobster bait ('yum-yums') and targeting of small fish. The total removals of 2 year olds increased from 263 million to 482 million (83% increase) and made up 60% of the overall TAC by number and 32% by weight. This is the largest percentage of two year-olds since 1968. The mean age of the catch was 2.7 which is lower than the age at first maturity and one of the lowest observed.

## **ASSESSMENT FOR THE SOUTHWEST NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT**

In 2009, the fishery catch at age composition was comprised of 45% fish by number at 2 years of age and 7% older than age 5. In 2010 there were 60% fish by number at age 2 and only 3% older than age 5 in the catch (Figure 3). This decrease of older/larger fish in the catch cannot be explained by just the very high proportion of 2 year olds. The 2005 year class at age 5 was prominent in the 2010 catch and can be tracked in the historical catch at age (Figure 4).

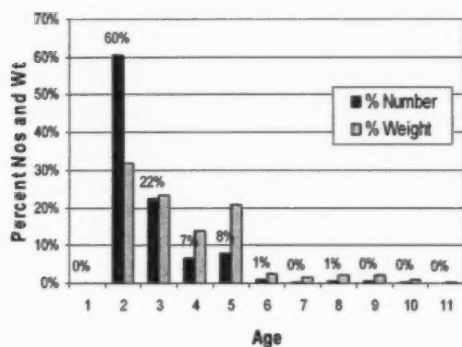


Figure 3. Fishery catch at age (% numbers and % weight) for SW Nova Scotia/Bay of Fundy spawning component (2009-2010 quota year).

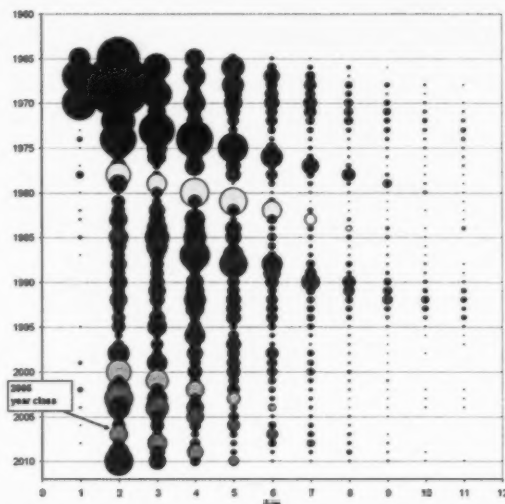


Figure 4. Historical catch at age for SW Nova/Bay of Fundy spawning component from 1965-2010. Selected year classes shown with 2005 indicated.

The total number of fish removed by the fishery was calculated to be 796 million, an increase of 209 million or 36% from 2009 with landings reduced by 9,466t.

The acoustic surveys that document primarily spawning fish at age 3 and older have an age composition different from the fishery. Acoustic survey age composition had a broad age distribution of spawning fish with ages 3-11 and 15% older than age 5. There was a broader distribution of age-classes in the acoustic catch at age compared to the commercial catch at age. The proportion of fish at age 6 and older was 15% in the acoustic survey catch at age compared with 7% in the fishery catch at age (for ages 3+). The mean age of the acoustic catch at age increased from 4.3 to 4.8 years in 2010 and was higher than the mean age in the catch. The 2005 year class (at age 5) continued to represent the highest proportion by number on the spawning grounds (Figure 5).

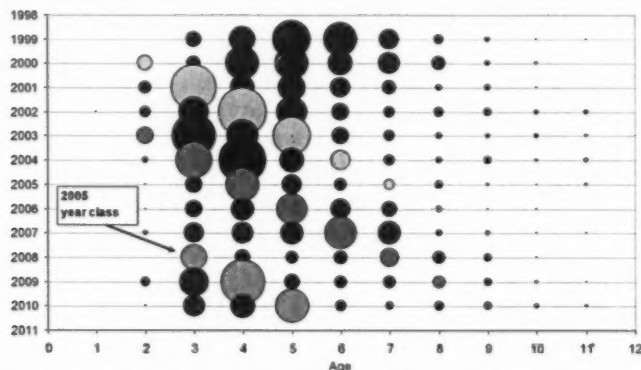


Figure 5. Acoustic survey age composition for the overall SW Nova/Bay of Fundy spawning component.

## Acoustic Surveys

Industry led surveys with automated acoustic recording systems deployed on commercial fishing vessels were used to document the distribution and abundance of spawning herring. Scheduled surveys were conducted approximately every 2 weeks on the main spawning components and an index of spawning stock biomass (SSB) for each component was estimated by summing these results (Table 2) (Figure 6).

Table 2. Acoustic survey spawning biomass index for SW Nova Scotia / Bay of Fundy spawning component for 1999 to 2010 ('000's t).

| Location/Year                | 2001       | 2002       | 2003       | 2004       | 2005       | 2006       | 2007       | 2008       | 2009       | 2010       | Average<br>2001-2010 |
|------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------------------|
| Scots Bay (inbox)            | 216        | 130        | 123        | 115        | 21         | 32         | 51         | 23         | 82         | 42         | 83                   |
| Scots Bay (outbox)           |            |            |            |            |            |            | 2          |            | 6          | 12         | 5                    |
| Scots Bay total              | 216        | 130        | 123        | 115        | 21         | 32         | 53         | 23         | 88         | 54         | 85                   |
| German Bank (inbox)          | 257        | 416        | 349        | 392        | 269        | 291        | 495        | 239        | 396        | 235        | 334                  |
| German Bank (outbox)         |            |            |            |            |            | 5          | 4          | 2          | 2          | 19         | 6                    |
| German Bank total            | 257        | 416        | 349        | 392        | 269        | 295        | 499        | 241        | 398        | 254        | 337                  |
| Trinity Ledge                | 15         | 9          | 12         | 12         | 11         | 16         | 3          | 1          | 2          | 2          | 8                    |
| Spec Buoy (spring)           | 1          | 0          | 1          | n/s        | 1          | n/s        | 0          | 0          | n/s        | 2          | 1                    |
| Spec Buoy (fall)             | 88         |            |            |            |            |            |            |            |            |            | 44                   |
| <b>Stock Areas Sub-Total</b> | <b>577</b> | <b>555</b> | <b>485</b> | <b>519</b> | <b>301</b> | <b>343</b> | <b>556</b> | <b>265</b> | <b>487</b> | <b>312</b> | <b>440</b>           |
| Seal Island                  | 4          | 1          | 12         |            |            | 10         |            |            |            |            | 7                    |
| Browns Bank                  | 50         |            |            |            |            | 8          |            |            |            |            | 29                   |
| <b>Total All Areas</b>       | <b>631</b> | <b>556</b> | <b>497</b> | <b>519</b> | <b>301</b> | <b>361</b> | <b>556</b> | <b>265</b> | <b>487</b> | <b>312</b> | <b>448</b>           |

Six surveys were conducted in Scots Bay in 2010 (Figure 7). There was no sampling of the first survey, with fish depth distribution not typical of spawning fish, so it was excluded from the SSB estimate. Eight surveys were conducted on German Bank, 5 of which were used in the estimate of SSB. Individual survey area coverage was good and consistent with established protocols.

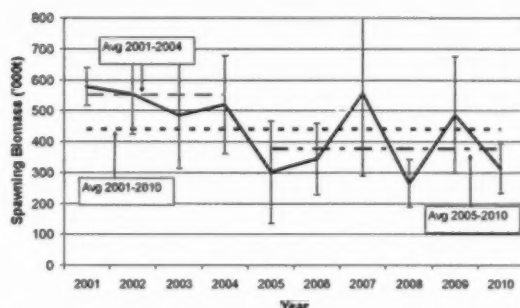


Figure 6. SSB index from acoustic surveys for the overall SW Nova Scotia/Bay of Fundy spawning component.

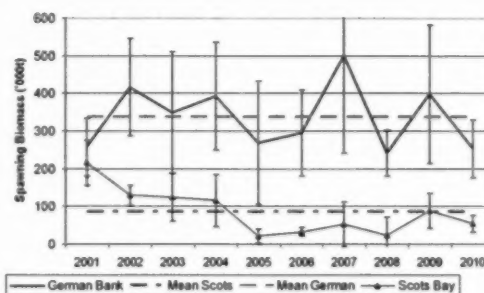


Figure 7. SSB index from acoustic surveys for Scots Bay and German Bank.

The amount of spawning fish documented on Trinity Ledge in 2010 was again extremely low and survey coverage was very limited with only 2 surveys completed on small areas of spawning fish. There were no surveys and no reports of spawning herring around Seal Island and Browns Bank grounds. No spring fishery took place on Spectacle Buoy in 2010 but 3 surveys were completed in the area.

In 2010, biomass estimates decreased in the main areas for Scots Bay and German Bank to a total of 312kt, which is a decrease of approximately 175kt from 2009 (36% decrease) (Figure 6, 7). About 10-15% of the observed decline in SSB from 2009 to 2010 can be attributed to a change in target strength due to the reduced mean weight at age.

### **Stock Trends and Current Status**

Stock status and scientific advice in 2010-2011 is based on some of the recommendations from the January 2011 framework as follows (DFO 2011).

1. Report on criteria for survey and sampling and identify anomalies
2. Signs of change using the following indicators:
  - a. survey biomass trends,
  - b. fishermen input,
  - c. numbers or proportion at age in catch and survey,
  - d. trends in relative exploitation rates using catch and acoustic survey spawning biomass estimates, and
  - e. mortality rate trends based on age composition,  $F=Z-M$ .

The advice is also based on evaluation of the conservation objectives identified in the management plan (DFO 2003) and finally consideration is given to the significant changes in condition factor (weight at age, fat content) observed in 2010.

In the absence of an analytical assessment model, advice is based on both the observations of all the above elements and the conclusions that were drawn from an evaluation of these elements (Table 3, 4).

*Table 3. Observations on conservation objective elements from the management plan for SW Nova Scotia / Bay of Fundy spawning component in 2010.*

| <b>Objective in the Management Plan</b> | <b>Observations</b>                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Persistence of all spawning components  | Scots and German are persisting but not other areas.                                                                                                                                                                                                                                                                            |
| Maintain biomass of each component      | Scots Bay average SSB was 146kt from 2001-2004 and 45kt from 2005-2010. The 2010 value was 54kt.<br>German Bank: was fluctuating around the 2001 to 2010 mean except for 2008 and 2010 which are below the mean.<br>Trinity Ledge: 2001-2006 SSB varied from 10-16kt, but since 2007 is below 4kt. Seal Island: No information. |
| Maintain broad age composition          | 2010 commercial catch at age contained ages 1-11 but there was a lack of fish older than age 5 (only 2%). Proportion older than age 6 in the catch is reduced since 1995.<br>Acoustic survey age composition had a broad age distribution of spawning fish with ages 3-11 and 15% older than age 5.                             |
| Maintain long spawning period           | Scots Bay has shown an increase in the length of spawning period recently. German Bank had a spawning period in 2010 similar to previous years. Trinity with a very short period.                                                                                                                                               |
| Fishing mortality at or below $F_{0.1}$ | Fishing mortality was not determined. Relative estimates of trends in fishing and total mortality are fluctuating around the mean (Figure 8-9).                                                                                                                                                                                 |

| Objective in the Management Plan                    | Observations                                                                                                                                                                                                                                                   |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Maintain spatial and temporal diversity of spawning | Scots Bay with a change in spatial distribution with more catches and biomass outside the survey area box. German Bank in 2010 showed good spawning distribution in comparison to recent historical distribution. Trinity had a very restricted spawning area. |
| Maintain biomass at moderate to high levels         | Mean SSB decreased from 551kt for 2001-2004 to 377kt for 2005-2010.                                                                                                                                                                                            |

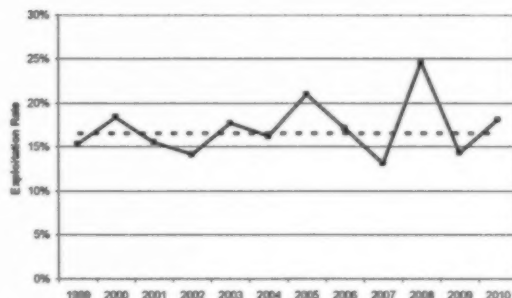


Figure 8. Relative exploitation rate using overall catch as a proportion of the overall acoustic SSB..

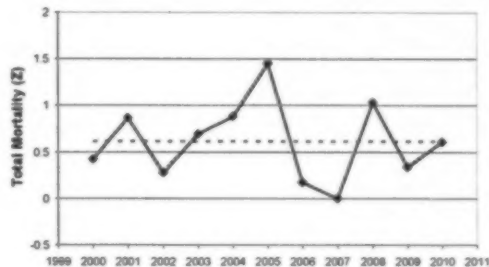


Figure 9. Total mortality estimates from the overall acoustic age composition for ages 4-8 compared with ages 5-9 in the following year.

#### Observations on Fish Condition

1. SWNS, where the majority of catch takes place, had the lowest condition factor on record in 2010 since 1974. For the inner Bay of Fundy in Scots Bay and on the Scotian Shelf there was no trend in condition factor.
2. Fat content was among the lowest levels previously observed in 1994 and 1998.
3. There was a negative relationship between condition factor and annual temperature and a positive relationship with annual chlorophyll in SW Nova Scotia and the outer Bay of Fundy.

Time-series examination of surface water conditions affecting the outer Bay of Fundy and SW Nova Scotia and chlorophyll concentration for the same two areas from July through September indicates that 2010 was an unusual year from most in recent years. Observations of fat content suggest that these environmental factors may have had an affect on the availability of food for the summer months for SW Nova Scotia and the outer Bay of Fundy.

There has been a trend of declining mean-weight at age but it was significantly more than would have occurred if the trend continued in 2010 (Figure 10). This unexpected reduction was consistent with the unusual environmental conditions in 2010. Declining trends in mean-weight at age since the 1970s has reduced productivity of the stock.

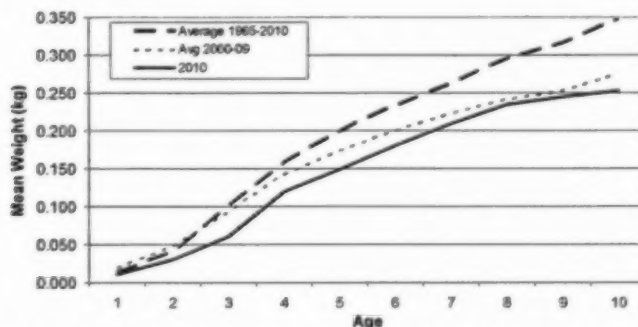


Figure 10. Fishery weights at age for 2010 season compared with the recent 10 years and overall time series for 1965-2010.

The observations from the conservation objective elements in the management plan for SW Nova Scotia / Bay of Fundy spawning component in 2010 were evaluated and the following conclusions were made from all the available data including observations and opinions from fishermen and industry participants (Table 4).

Table 4. Conclusions for the conservation objective elements from the management plan for SW Nova Scotia / Bay of Fundy spawning component in 2010.

| Objective in the Management Plan                    | Conclusions from Observations                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Persistence of all spawning components              | Only two major spawning areas remain in the SWNS/BOF component.                                                                                                                                                                                                                                                                                                                                                            |
| Maintain biomass of each component                  | German Bank: Biomass is being maintained without any signs of increase over the past decade. The current level relative to historic abundance is not quantifiable.<br>Scots Bay average SSB was 146kt from 2001-2004 and 45kt from 2005-2010. The 2010 Scots Bay SSB estimate was 54kt.<br>Trinity Ledge: Spawning biomass is very low with no signs of recovery over the last 4 years.<br>Seal: No information on trends. |
| Maintain broad age composition                      | There is a relative broad age distribution on both of the major spawning grounds and the stock. The age composition is dominated by fish at ages 5 and younger.                                                                                                                                                                                                                                                            |
| Maintain long spawning period                       | Spawning periods are being maintained on the two major spawning grounds.                                                                                                                                                                                                                                                                                                                                                   |
| Fishing mortality at or below $F_{0.1}$             | Currently do not have a method for estimating $F$ with respect to $F_{0.1}$ , however, relative exploitation rate has been constant in response to changes in survey biomass in the two time periods from 2001-2004 and 2005-2010.                                                                                                                                                                                         |
| Maintain spatial and temporal diversity of spawning | The spatial diversity of spawning was maintained on German Bank and in Scots Bay.                                                                                                                                                                                                                                                                                                                                          |
| Maintain biomass at moderate to high levels         | Acoustic survey SSB is fluctuating around the average. The total annual SSB confidence intervals ( $P < 0.05$ ) include the 2001-2010 average with the exception of 2008 and 2010. There appears to have been a marked decline in 2005. The fluctuations in total SSB from 2005-2010 is around the average for this period except for 2008 (Figure 6).                                                                     |

### **Sources of Uncertainty**

There is no independent index of recruitment. The size of the recruiting 2008 year class is unknown but made up 60% (by number) of the catch at age 2 in 2010.

The mechanisms causing changes in fish condition is not understood.

The assumption that the surveys are additive continues to be a source of uncertainty (DFO 2007).

The advice uses relative trends in spawning stock biomass and exploitation rate because there is no accepted population assessment model. This creates a difficulty in putting current SSB levels in a historical context when using trend data only for the period from 1999-2010.

### **CONCLUSIONS AND ADVICE**

The conclusions for this stock are drawn from the observations described in the stock trends and current status section.

SSB has declined from the average of 551kt to 377kt (32% reduction) for the time periods 2001-2004 to 2005-2010. This assessment indicates stability at the lower level from 2005-2010 and shows little or no signs of improvement. This lack of rebuilding despite reduced catch levels in recent years is cause for concern.

Harvest strategy that exercises caution, including additional restrictions in small fish removals, is appropriate.

### **OTHER CONSIDERATIONS**

Observer reports of by-catch in purse seine sets have reported very small amounts of non-herring species, most of which are released unharmed.

### **ASSESSMENT, CONCLUSIONS AND ADVICE FOR OTHER COMPONENTS**

#### **Offshore Scotian Shelf**

Since 1996, a fishery has taken place on feeding aggregations on the offshore banks of the Scotian Shelf, primarily in May and June, with catches ranging from 1,000 to 20,000t (Figure 11). In 2010, almost the entire allocation was caught with total landings above average at 11,862t, up from only 920t in 2008. Most landings were caught by purse seiners in May and June, in the vicinity of the Patch, Emerald Bank and the Western Hole. Additional by-catch (25t) was reported from otter trawl fisheries for ground fish and silver hake on the Scotian Shelf.

In 2010, the age composition of the catch was mostly adult herring with age 5 dominating by number and weight (Figure 12).

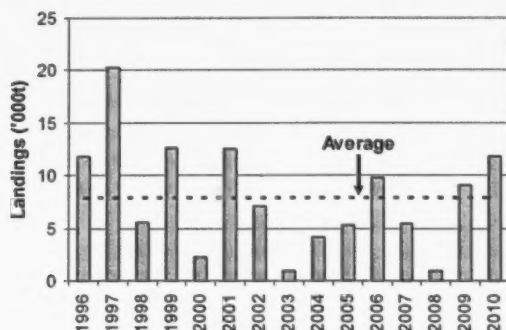


Figure 11. Offshore Scotian Shelf herring landings since 1996 with overall average for the period.

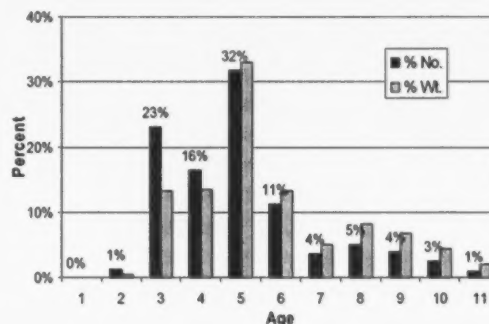


Figure 12. Fishery catch at age (% numbers and % weight) for the 2010 Offshore Scotian Shelf herring component.

An industry survey of the offshore Scotian Shelf area was conducted on 'The Patch' in June 2010, with 3.5kt of biomass estimated. The DFO summer ecosystem trawl survey index, which previously demonstrated considerable abundance of herring widely spread over the Scotian Shelf, increased substantially from a below average level in 2009 (39 to 300 per tow). The bottom trawl data are not considered indicative of overall herring abundance but are useful to document herring distribution and biological attributes such as size, age, maturity and condition.

There is minimal new information to add and no reason to change the previous recommendation that the initial catch allocation for 2011 should not exceed 12,000t as described in the DFO management plan. The industry is again encouraged to explore and undertake further structured surveys of the offshore area in 2011.

### **Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia**

There is no quota for the coastal Nova Scotia spawning component. Apart from the four areas indicated in Table 5, the size and historical performance of various spawning groups are poorly documented. In addition to the traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds since 1996.

Table 5. Recorded landings (thousands of tonnes) of herring from major gillnet fisheries on the Coastal Nova Scotia spawning component for 1996 to 2010.

| Landings (000's t)      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Landings                | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Little Hope/Port Mouton |      | 0.5  | 1.2  | 2.9  | 2.0  | 2.9  | 4.0  | 4.5  | 1.3  | 2.2  | 3.1  | 1.5  | 1.1  | 3.7  | 3.1  |
| Halifax/Eastern Shore   | 1.3  | 1.5  | 1.1  | 1.6  | 1.4  | 1.9  | 3.3  | 2.7  | 4.2  | 3.5  | 3.4  | 3.7  | 2.4  | 6.0  | 2.5  |
| Glance Bay              |      | 0.2  | 1.7  | 1.0  | 0.8  | 1.2  | 3.1  | 1.9  | 1.5  | 0.6  | 0.1  | 0.0  | 0.0  | 0.0  | 0.0  |
| Bras d'Or Lakes         | 0.2  | 0.2  | 0.1  | 0.0  | 0.1  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Total                   | 1.5  | 2.3  | 4.1  | 5.6  | 4.3  | 6.0  | 10.4 | 9.1  | 7.0  | 6.3  | 6.6  | 5.3  | 3.5  | 9.8  | 5.6  |

The landings in the roe gillnet fisheries along the coast of Nova Scotia decreased from 9,783t in 2009 to 5,575t in 2010. From 2009 to 2010, landings decreased from 3,731t to 3,106t in the Little Hope/Port Mouton area and from 6,045t to 2,456t in the Eastern Shore area. Catch levels in 2010 were managed based on observed acoustic biomass from the recent 5 year average as well as acoustic biomass observed during the season (using the survey, assess and fish protocol). Landings were minimal for Glance Bay. The Bras d'Or Lakes area remained closed. There was an additional 12t landed from trap nets located in Cape Breton and St. Margaret's Bay. In 2010, the age composition of the catch for the overall component was primarily adult

herring from this size selective gillnet fishery with a substantial proportion (95%) at age 5 and older (Figure 13).

As the inshore roe gillnet fisheries off Glace Bay, East of Halifax and Little Hope developed (since 1996), participants have contributed to sampling and surveying. In 2009, there was a large increase in the surveyed biomass in the Little Hope/Port Mouton area from 14.5kt to 36.6kt. In 2010 the survey biomass for the Little Hope/Port Mouton area declined to 26.7kt, just above the recent 5 year average of 20.9kt (Table 6, Figure 14). The survey biomass in the Halifax/Eastern shore area saw a large increase in 2009 to 54.2kt but in 2010 declined to 27.7kt, well below the recent 5 year average of 41.9kt (Figure 15). Surveys were also completed near Glace Bay, but there were very little spawning herring documented or catch reported (Figure 16). No herring surveys have been conducted in the Bras d'Or Lakes since 2000.

Table 6. Estimated herring acoustic SSB (thousands of tonnes) and recent 5 year average for the Coastal Nova Scotia spawning component areas as calculated with the CIF.

| Acoustic Survey SSB     | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Average 2006-2010 |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------------------|
| Little Hope/Port Mouton | 14.1 | 15.8 | 5.2  | 21.3 | 56.0 | 53.1 | 22.5 | 44.7 | 24.1 | 2.8  | 14.5 | 36.6 | 26.7 | 20.9              |
| Halifax/Eastern Shore   | 8.3  | 20.2 | 10.9 | 16.7 | 41.5 | 92.6 | 28.4 | 37.0 | 68.9 | 28.3 | 30.3 | 54.2 | 27.7 | 41.9              |
| Glace Bay               | 0.0  | 2.0  | 0.0  | 21.2 | 7.7  | 31.5 | 0.0  | 3.2  | n/s  | 0.2  | 0.5  | 0.1  | 0.0  | 0.2               |
| Bras d'Or Lakes         | 0.0  | 0.5  | 0.1  | n/s  | n/s  | n/s  | n/s  | n/s  | n/s  | n/s  | n/s  | n/s  | n/s  | no surveys        |

n/s - no survey

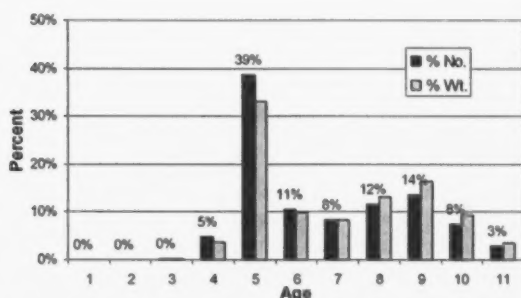


Figure 13. Fishery catch at age (% numbers and % weight) for the 2010 Coastal Nova Scotia herring component.

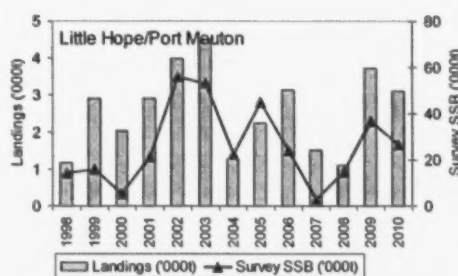


Figure 14. Landings and acoustic survey SSB ('000t) for the Little Hope/Port Mouton gillnet fishery for 1998-2010.

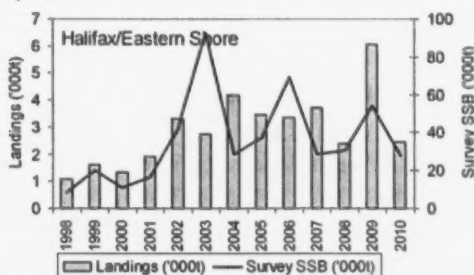


Figure 15. Landings and acoustic survey SSB ('000t) for the Halifax/Eastern Shore gillnet fishery for 1998-2010.

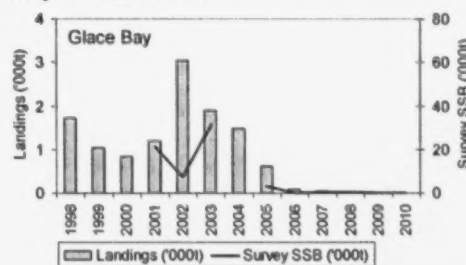


Figure 16. Landings and acoustic survey SSB ('000t) for the Glace Bay gillnet fishery for 1998-2010.

Collaborative research with industry has improved knowledge of three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge of other areas. Individual spawning groups within this component are considered vulnerable to

fishing because of their relatively small size and proximity to shore. It is again recommended that no coastal spawning groups experience a large effort increase in new areas until enough information is available to evaluate the state of that spawning group.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern, but there has been no research or surveys in recent years. It is; therefore, appropriate to reiterate that no fishing should take place on this spawning component.

Harvest levels from these areas use a five year average of recent catches and/or surveyed acoustic biomass with the Calibration Integration Factor (CIF) to set initial targets. It is recommended that the "survey, assess, then fish" protocol should continue to be applied.

### **SW New Brunswick Migrant Juveniles**

The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy. These fish are considered to be a mixture of juveniles, dominated by those originating from Northwest Atlantic Fisheries Organization (NAFO) Subarea 5 spawning components, and have, therefore, been excluded from the SW Nova Scotia/Bay of Fundy quota.

Landings in the 2010 New Brunswick weir and shut-off fishery were 10,958t, up from the low of 4,031t in the previous year. It is notable that as recently as 2007 landings were 30,944t, the highest in nearly 20 years and higher than the long term average of 23,560t (Figure 17). The age distribution of fish caught in the 2010 New Brunswick weir and shutoff fishery were mostly juveniles, which are well suited to the sardine market, with 95% at age 2 (Figure 18). The number of weirs with catches increased in the 2010 season, but effort (number of active weirs) remained similar.

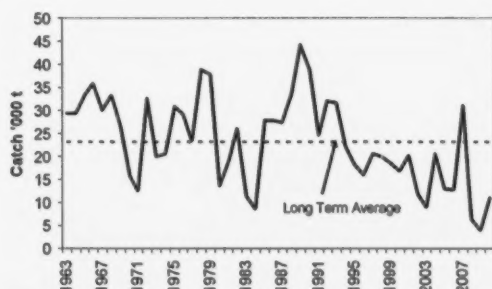


Figure 17. Herring landings from New Brunswick weir and shutoff fishery for 1963-2010 with long term average catch.

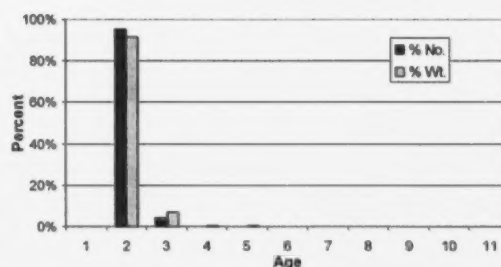


Figure 18. Fishery catch at age (% numbers and % weight) for the 2010 SW New Brunswick migrant juvenile herring component.

The success of this passive fishery is historically unpredictable, and catches are inherently susceptible to many natural variables in addition to abundance.

## SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of 7-8 April 2011 on NAFO Divisions 4VWX Herring stock assessments. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

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